# TEST REPORT

## Test Report No. : UL-RPT-RP14705831-1016B

| | | |
|---|---|---|
| **Customer** | : | Raspberry Pi LTD |
| **Model No. / HVIN** | : | V2.0 |
| **PMN** | : | Raspberry Pi 5 |
| **FCC ID** | : | 2ABCB-RPI5 |
| **ISED Certification No.** | : | IC: 20953-RPI5 |
| **Test Standard(s)** | : | FCC Part 15.207<br>Innovation, Science and Economic Development Canada<br>RSS-Gen Issue 5 February 2021 |
| **Test Laboratory** | : | UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH, United Kingdom |

1. This test report shall not be reproduced except in full, without the written approval of UL International (UK) Ltd.
2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

**Date of Issue:** 17 October 2023

**Checked by:**

Ben Mercer
Lead Project Engineer, Radio Laboratory

**Company Signatory:**

Sarah Williams
RF Operations Leader, Radio Laboratory

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## Customer Information

| | |
|---|---|
| **Company Name:** | Raspberry Pi LTD |
| **Address:** | Maurice Wilkes Building St. John's Innovation Park,<br>Cambridge,<br>CB4 0DS,<br>United Kingdom |

## Report Revision History

| Version Number | Issue Date | Revision Details | Revised By |
|---|---|---|---|
| 1.0 | 15/09/2023 | Initial Version | Ben Mercer |
| 2.0 | 17/10/2023 | FVIN removed | Ben Mercer |

# Table of Contents

# 1 Attestation of Test Results

## 1.1 Description of EUT

The equipment under test was a single board computer with *Bluetooth*, 2.4 GHz WLAN and 5 GHz WLAN transceivers.

## 1.2 General Information

| | |
|---|---|
| **Specification Reference:** | 47CFR15.207 |
| **Specification Title:** | Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.207 |
| **Specification Reference:** | RSS-Gen Issue 5 February 2021 |
| **Specification Title:** | General Requirements for Compliance of Radio Apparatus |
| **Site Registration:** | FCC: 685609, ISEDC: 20903 |
| **FCC Lab. Designation No.:** | UK2011 |
| **ISEDC CABID:** | UK0001 |
| **Location of Testing:** | Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom |
| **Test Dates:** | 28 July 2023 |

## 1.3 Summary of Test Results

| FCC Reference (47CFR) | ISED Canada Reference | Measurement | Result |
|---|---|---|---|
| Part 15.207 | RSS-Gen 8.8 | Transmitter AC Conducted Emissions | Complied |

## 1.4 Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

# 2 Summary of Testing

## 2.1 Facilities and Accreditation

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom.

UL International (UK) Ltd is accredited by the United Kingdom Accreditation Service (UKAS). UKAS is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) Arrangement for the mutual recognition of test reports. The tests reported herein have been performed in accordance with its terms of accreditation.

## 2.2 Methods and Procedures

| | |
|---|---|
| **Reference:** | ANSI C63.10-2013 |
| **Title:** | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| **Reference:** | KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015 |
| **Title:** | AC Power-Line Conducted Emissions Frequently Asked Questions |

## 2.3 Calibration and Uncertainty

### Measuring Instrument Calibration

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

### Measurement Uncertainty & Decision Rule

#### Overview

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

#### Decision Rule

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

#### Measurement Uncertainty

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

| Measurement Type | Range | Confidence Level (%) | Calculated Uncertainty |
|---|---|---|---|
| AC Conducted Spurious Emissions | 0.15 MHz to 30 MHz | 95% | ±2.42 dB |

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

## 2.4 Test and Measurement Equipment

### Test Equipment Used

| Asset No. | Instrument | Manufacturer | Type No. | Serial No. | Date Calibration Due | Cal. Interval (Months) |
|---|---|---|---|---|---|---|
| M2037 | Thermohygrometer | Testo | 608-H1 | 45124925 | 08 Dec 2023 | 12 |
| M1124 | Test Receiver | Rohde & Schwarz | ESIB26 | 100046 | 06 Oct 2023 | 12 |
| A649 | LISN | Rohde & Schwarz | ESH3-Z5 | 825562/008 | 01 Sep 2023 | 12 |
| A1830 | Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 100668 | 01 Jun 2024 | 12 |

### Test Measurement Software/Firmware Used:

| Name | Version | Release Date |
|---|---|---|
| Rohde & Schwarz EMC32 | 6.30.0 | 2018 |

# 3 Equipment Under Test (EUT)

## 3.1 Identification of Equipment Under Test (EUT)

| | |
|---|---|
| **Brand Name:** | Raspberry Pi |
| **Model Name or Number / HVIN:** | V2.0 |
| **PMN:** | Raspberry Pi 5 |
| **Test Sample Serial Number:** | R29 |
| **Hardware Version:** | V2.0 |
| **Software Version:** | V1.0 |
| **FCC ID:** | 2ABCB-RPI5 |
| **ISED Canada Certification Number:** | IC: 20953-RPI5 |
| **Date of Receipt:** | 17 May 2023 |

## 3.2 Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

## 3.3 Additional Information Related to Testing

| | | | |
|---|---|---|---|
| **Technology Tested:** | *Bluetooth* | | |
| **Channel Spacing:** | 1 MHz | | |
| **Mode:** | Basic Data Rate | | |
| **Modulation:** | GFSK | | |
| **Packet Type (Maximum Payload):** | DH5 | | |
| **Data Rate:** | 1 Mbps | | |
| **Transmit Frequency Range:** | 2402 MHz to 2480 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Middle | 39 | 2441 |

| | | | |
|---|---|---|---|
| **Technology Tested:** | *Bluetooth* Low Energy (Digital Transmission System) | | |
| **Channel Spacing:** | 2 MHz | | |
| **Modulation:** | GFSK | | |
| **Data Rate:** | 1 Mbps (LE1M) | | |
| **Transmit Frequency Range:** | 2402 MHz to 2480 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Middle | 17 | 2440 |

| | | | |
|---|---|---|---|
| **Technology Tested:** | WLAN (IEEE 802.11b,g,n) / Digital Transmission System | | |
| **Channel Spacing:** | 20 MHz | | |
| **Modulation:** | BPSK | | |
| **Data Rate:** | 802.11n HT20 | MCS0 (SISO) | |
| **Transmit Frequency Range:** | 2412 MHz to 2472 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Bottom | 1 | 2412 |

| | | | |
|---|---|---|---|
| **Technology Tested:** | WLAN (IEEE 802.11a,n,ac) / U-NII | | |
| **Channel Spacing:** | 20 MHz | | |
| **Modulation:** | BPSK | | |
| **Data Rate:** | 802.11n HT20 | MCS0 | |
| **Transmit Frequency Band:** | 5470 MHz to 5725 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Top | 140 | 5700 |

## 3.4 Description of Available Antennas

The radio utilises an integrated antenna, with the following maximum gain:

| Frequency Range (MHz) | Antenna Gain (dBi) |
|---|---|
| 2400 to 2480 | 3.5 |
| 5150 to 5850 | 2.5 |

## 3.5 Description of Test Setup

### Support Equipment

The following support equipment was used to exercise the EUT during testing:

| | |
|---|---|
| **Description:** | Test Laptop |
| **Brand Name:** | Lenovo |
| **Model Name or Number:** | L480 |
| **Serial Number:** | PF1EJ3BY |

| | |
|---|---|
| **Description:** | AC to DC Power Adaptor |
| **Brand Name:** | Raspberry Pi |
| **Model Name or Number:** | KSA-15E-051300HK |
| **Serial Number:** | Not stated or marked |

| | |
|---|---|
| **Description:** | ThinkPad USB-C Docking station |
| **Brand Name:** | Lenovo |
| **Model Name or Number:** | Type 4049 |
| **Serial Number:** | Not stated or marked |

| | |
|---|---|
| **Description:** | Micro-HDMI Cable. Length 1m. Quantity 2. |
| **Brand Name:** | Raspberry Pi |
| **Model Name or Number:** | SC0270 |
| **Serial Number:** | Not stated or marked |

| | |
|---|---|
| **Description:** | USB/HDMI/Ethernet Termination Hub. Quantity 2. |
| **Brand Name:** | Lemorele |
| **Model Name or Number:** | TC19 |
| **Serial Number:** | Not stated or marked |

| | |
|---|---|
| **Description:** | USB Type A Cable. Length 3m. Quantity 4. |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | Ethernet Cable. Length 2m. Quantity 1. |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

## Operating Modes

The EUT was tested in the following operating mode(s):

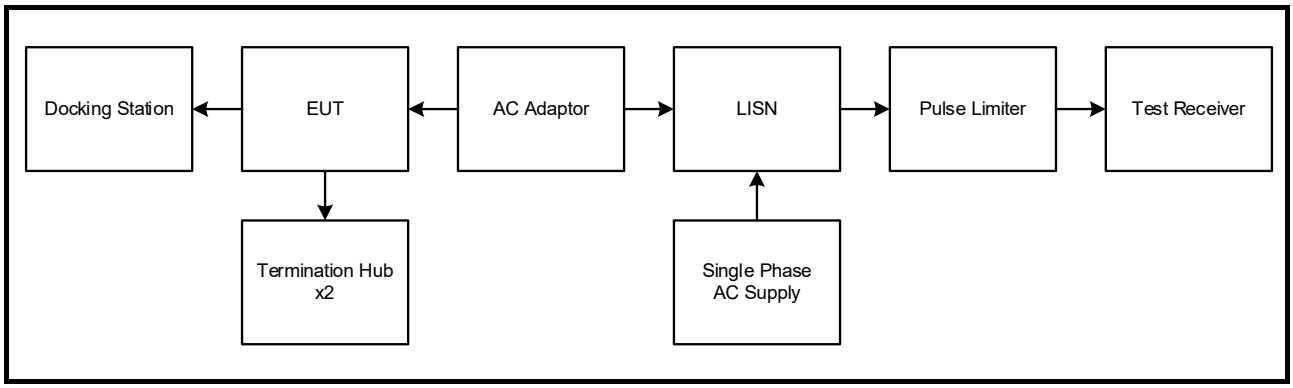
- Transmitting at maximum power in the relevant mode as required.
- The EUT was tested in the following operating mode(s): Pre-scans were performed with the EUT transmitting in *Bluetooth* BDR, *Bluetooth* LE, 2.4 GHz and 5 GHz WLAN modes individually. The worst-case mode was found to be *Bluetooth* LE. Final measurements were performed in this configuration.

## Configuration and Peripherals

The EUT was tested in the following configuration(s):

- Controlled in test mode using a set of commands entered into a terminal application on the EUT supplied by the customer. The commands were used to enable a continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions.
- All active ports were populated using suitable terminations.

## Test Setup Diagrams



# 4 AC Power Line Conducted Emissions Test Results

## 4.1 Transmitter AC Conducted Spurious Emissions

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineer:** | Andrew Edwards | **Test Date:** | 28 July 2023 |
| **Test Sample Serial Number:** | R29 | | |

| | |
|---|---|
| **FCC Reference:** | Part 15.207 |
| **Test Method Used:** | ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 25 |
| **Relative Humidity (%):** | 63 |

### Note(s):

1. The EUT was connected to an AC adaptor. The AC adaptor was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the 100 to 240V power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.

## Transmitter AC Conducted Spurious Emissions (continued)

### Results: Live / Quasi Peak / 120 VAC 60 Hz

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.150 | Live | 58.5 | 66.0 | 7.5 | Complied |
| 0.258 | Live | 51.5 | 61.5 | 10.0 | Complied |
| 0.285 | Live | 49.5 | 60.7 | 11.2 | Complied |
| 0.303 | Live | 48.1 | 60.2 | 12.1 | Complied |
| 0.438 | Live | 41.9 | 57.1 | 15.2 | Complied |
| 0.501 | Live | 41.4 | 56.0 | 14.6 | Complied |

### Results: Live / Average / 120 VAC 60 Hz

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.155 | Live | 33.7 | 55.8 | 22.1 | Complied |
| 0.164 | Live | 32.0 | 55.3 | 23.3 | Complied |
| 0.249 | Live | 22.7 | 51.8 | 29.1 | Complied |
| 0.420 | Live | 24.7 | 47.4 | 22.7 | Complied |
| 0.497 | Live | 28.3 | 46.1 | 17.8 | Complied |
| 0.821 | Live | 22.4 | 46.0 | 23.6 | Complied |

### Results: Neutral / Quasi Peak / 120 VAC 60 Hz

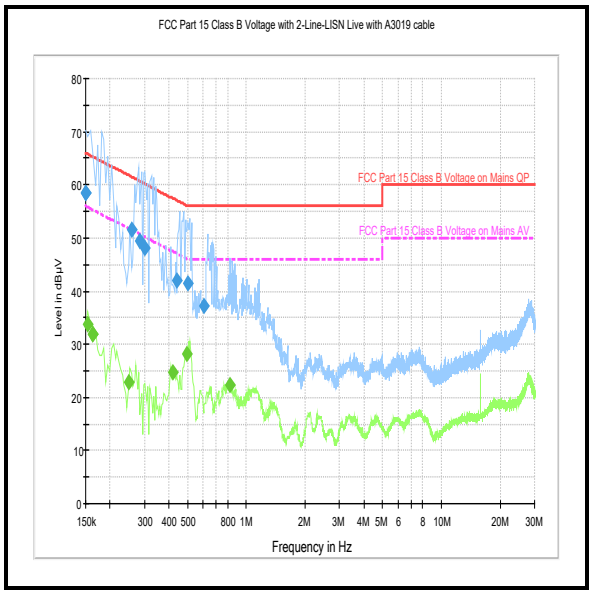
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.150 | Neutral | 58.5 | 66.0 | 7.5 | Complied |
| 0.155 | Neutral | 58.1 | 65.8 | 7.7 | Complied |
| 0.182 | Neutral | 56.5 | 64.4 | 7.9 | Complied |
| 0.285 | Neutral | 48.8 | 60.7 | 11.9 | Complied |
| 0.308 | Neutral | 49.0 | 60.0 | 11.0 | Complied |
| 0.510 | Neutral | 42.4 | 56.0 | 13.6 | Complied |

### Results: Neutral / Average / 120 VAC 60 Hz

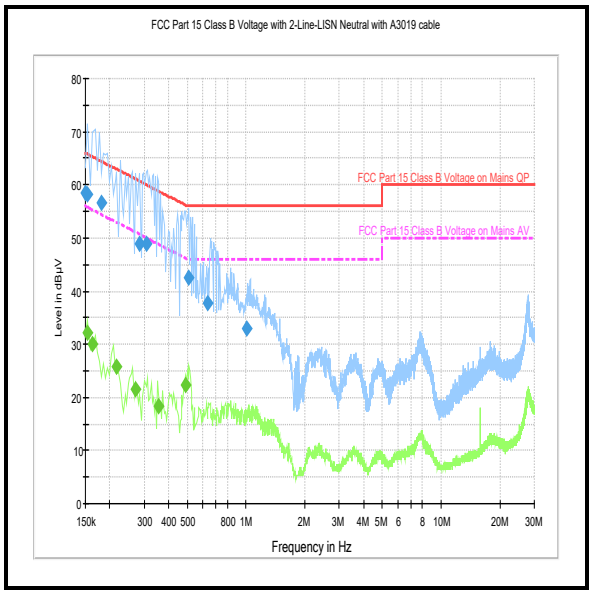
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.155 | Neutral | 32.0 | 55.8 | 23.8 | Complied |
| 0.164 | Neutral | 30.0 | 55.3 | 25.3 | Complied |
| 0.218 | Neutral | 25.7 | 52.9 | 27.2 | Complied |
| 0.272 | Neutral | 21.6 | 51.1 | 29.5 | Complied |
| 0.357 | Neutral | 18.4 | 48.8 | 30.4 | Complied |
| 0.492 | Neutral | 22.3 | 46.1 | 23.8 | Complied |

## Transmitter AC Conducted Spurious Emissions (continued)

## Results: 120 VAC 60 Hz




**Live**




**Neutral**

*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

## Transmitter AC Conducted Spurious Emissions (continued)

### Results: Live / Quasi Peak / 240 VAC 60 Hz

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.173 | Live | 43.7 | 64.8 | 21.1 | Complied |
| 0.249 | Live | 40.3 | 61.8 | 21.5 | Complied |
| 0.339 | Live | 39.9 | 59.2 | 19.3 | Complied |
| 0.479 | Live | 37.9 | 56.4 | 18.5 | Complied |
| 0.785 | Live | 33.2 | 56.0 | 22.8 | Complied |
| 0.879 | Live | 33.4 | 56.0 | 22.6 | Complied |

### Results: Live / Average / 240 VAC 60 Hz

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.168 | Live | 31.8 | 55.1 | 23.3 | Complied |
| 0.168 | Live | 31.8 | 55.1 | 23.3 | Complied |
| 0.254 | Live | 29.2 | 51.6 | 22.4 | Complied |
| 0.339 | Live | 28.6 | 49.2 | 20.6 | Complied |
| 0.474 | Live | 30.4 | 46.4 | 16.0 | Complied |
| 0.879 | Live | 23.7 | 46.0 | 22.3 | Complied |

### Results: Neutral / Quasi Peak / 240 VAC 60 Hz

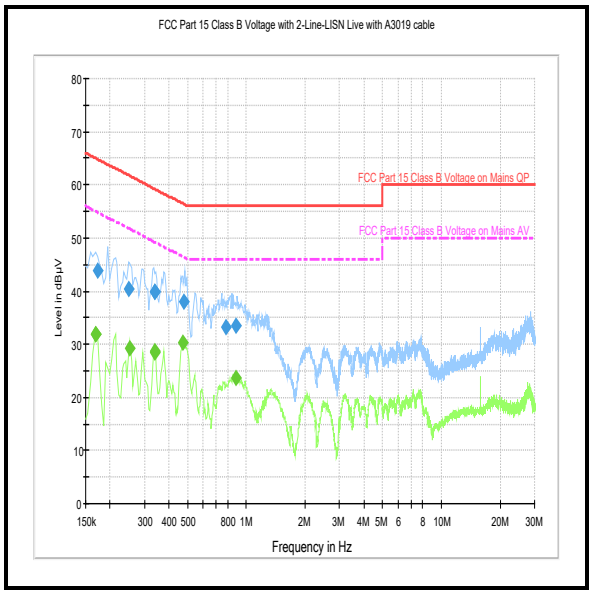
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.168 | Neutral | 46.9 | 65.1 | 18.2 | Complied |
| 0.335 | Neutral | 40.9 | 59.3 | 18.4 | Complied |
| 0.348 | Neutral | 38.9 | 59.0 | 20.1 | Complied |
| 0.483 | Neutral | 40.8 | 56.3 | 15.5 | Complied |
| 0.537 | Neutral | 34.8 | 56.0 | 21.2 | Complied |
| 0.857 | Neutral | 35.0 | 56.0 | 21.0 | Complied |

### Results: Neutral / Average / 240 VAC 60 Hz

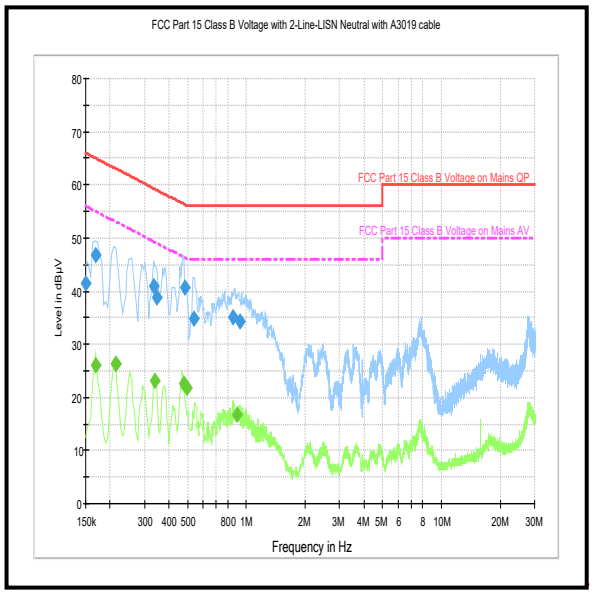
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.168 | Neutral | 26.0 | 55.1 | 29.1 | Complied |
| 0.213 | Neutral | 26.3 | 53.1 | 26.8 | Complied |
| 0.339 | Neutral | 23.0 | 49.2 | 26.2 | Complied |
| 0.479 | Neutral | 22.7 | 46.4 | 23.7 | Complied |
| 0.497 | Neutral | 21.7 | 46.1 | 24.4 | Complied |
| 0.897 | Neutral | 16.7 | 46.0 | 29.3 | Complied |

## Transmitter AC Conducted Spurious Emissions (continued)

## Results: 240 VAC 60 Hz




**Live**




**Neutral**

*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**--- END OF REPORT ---**